Difficulties of Limiting Entry into the Overcapitalized Florida Spiny Lobster Fishery

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RESUMEN

Las pesquerías floridanas de langostas espinosas han sido sobrecalculadas. Este trabajo senala y valúa este sobrecálculo y presenta un analisis económico de alternativas en la estrategia de límites de ingreso para reducir los empeños de pesca. También se discute el límite de ingreso comparándolo con otros programas convencionales de manejo de pesquerías.

In recent years, the most frequent and probably most confused concept in fishery management has been "limited entry." The basis of this confusion can be traced to confusion about two other concepts: (1) the economic concept of "overcapitalization" (or excess capacity) and (2) the biological concept of "overfishing." Most economically valuable common property resources face the economic problem of overcapitalization. That is, more fishing effort (a composite measure of human resources: capital, labor and fishing time) is utilized to exploit a resource than the minimum amount that is required to harvest any given catch.

Overcapitalization may also (but not necessarily) impair the biological yield of the resource being exploited (overfishing). It is theoretically impossible (on a sustainable yield basis) to have overfishing without overcapitalization. However, it is possible to have overcapitalization without overfishing. Whether overcapitalization leads to overfishing depends on regulations that are implemented within the context of a common property (open access) fishery. There is a considerable body of theoretical literature on why overcapitalization occurs in a common property resource and the connection between overcapitalization and overfishing (Scott, 1955; Schaefer, 1957; Turvey, 1964; Smith, 1969; Copes, 1970; Southey, 1972; Clark, 1977).

Limited entry is the only policy that directly prevents overcapitalization. It is a restriction on the number of productive units allowed in the fishery. Criteria for entry may take numerous forms such as willingness to pay an entrance fee, historical precedence, size of operation, or other characteristics (Mundt, 1974). The important point is that total fishing effort is less than would occur without limited entry and that this is achieved by rationing the resource to a population that is less than the total population that would otherwise exploit the resource.

SEPARATION OF POLICIES ADDRESSING OVERCAPITALIZATION AND OVERFISHING

What is important from a policy perspective is that while the economic problem of overcapitalization may result in the biological problem of overfishing, in almost every situation overfishing can be prevented without preventing overcapitalization.

In fact, conventional regulations such as gear restrictions, animal size limits, restricted hours or days, and closed seasons that are implemented to prevent overfishing can aggravate the economic problems associated with overcapitalization (Crutchfield, 1965).

All fishery policies have economic as well as biological implications. However, this does not imply that these biological and economic results can be satisfactorily used to justify the choice of one regulation over another unless a given regulation is the *only* one that can achieve a given biological and/or economic result. Stated differently, for the results of any regulation to be the sole justification for that regulation, that regulation must be a necessary (not just sufficient) condition for the result to occur.

This criteria is necessary because there is a family of regulations that can achieve the same results.

For example, limiting effort in a fishery or setting minimum size limits can be substitutable policies to maximize yield-per-recruit (Beverton and Holt, 1957). In some cases it could be concluded that restricting effort is preferable to minimize size restrictions because it results in a wider range of year classes that might be important for long run recruitment cycles. Since fishing effort is a composite of capital, labor, and fishing time, either gear restriction, restricted fishing hours or days, closed seasons, or limited entry could have the same biological result. But limited entry is the only regulation that controls effort by preventing overcapitalization. Therefore, the choice of limited entry over the other effort limiting policies must be based on arguments about overcapitalization. Limited entry must be justifiable as an economic regulation for economic purposes that also has biological results.

TWO ECONOMIC RATIONALES FOR PREVENTING OVERCAPITALIZATION

There are two separate economic issues with regards to overcapitalization. The first issue is economic efficiency. When more effort is utilized to exploit a resource than the minimum required, a nation (or region) loses the productivity of the human resources (labor and capital) that could be engaged in other economic activities. The rationale is that fisheries should not be evaluated in isolation from other sectors of an economy (Crutchfield, 1973). This argument depends on the mobility of the excess factors of production which is to a great extent determined by unemployment (or underemployment) that exists elsewhere in the economy.

The second issue is individual business profitability. In a market economy the observed profitability of any business is as much related to the opportunity cost of that business as any economic characterization of the industry. Opportunity cost is the financial return a business foregoes by not engaging in the most profitable alternative activity. If there are few attractive economic alternatives outside a fishery, the resulting returns in a fishery will be low. This has lead to the perceptive observation that when fishermen are relatively "poor", they are not poor because of the fishery but because they have low opportunity costs (few economic alternatives outside the fishery) (Gordon, 1954).

It is difficult to separate the cause and effect relationships between economic efficiency and business profitability in a limited entry fishery. If increased economic efficiency is the objective, then increased business profitability will also be the result unless a scheme is devised to prevent profits above opportunity cost (economic rent)

from accruing to participants (price controls, taxes). Conversely, limiting entry to increase profitability will result in increased efficiency.

Fishermen (as businessmen) support limited entry if they believe it will increase the profitability of their individual enterprise. Increased profitability in itself offers no advantage to the whole economy. Given controlled production through limited entry, fish prices to consumers are determined by demand such that prices will not be lower to consumers. The advantage to society (other than fishermen) can only be derived from increased national or regional efficiency from employing excess factors of production in a fishery in some other economic activity.

Historically, governments have not hesitated limiting entry into various industries (medieval guilds, merchantilist trading companies, public utilities, public airwaves, transportation routes, oil and gas reserves and lumber on public lands, and special retail licenses for liquors and taxis). Since efficiency and profitability cannot be easily separated, it is never completely clear as to which is the goal and which is the inadvertently resulting effect. In most cases presumably the goal is increased efficiency and the resulting effect is increased profitability. This can be presumed because in most of these cases limited entry is accompanied by price controls (for example, public service commissions) that restrict the profitability of businesses operating in a limited entry industry by directly passing the advantages of increased efficiency on to consumers through lower prices than would occur without limited entry. In some cases prices are not controlled but taxes are levied to restrict the profitability that occurs because of limited entry.

Unfortunately, price regulations that would directly benefit consumers of fishery products have a fundamental problem in fisheries, not encountered in regulated industries such as transportation and public utilities. In these industries the production level as well as the price can be regulated such that the market clears at any regulated price (quantity demanded equals quantity supplied). This is done by increasing or decreasing the number of productive units in the industry.

In a fishery, it is *not* possible to regulate production such that the market will clear at the regulated price that would pass the advantages of economic efficiency on to consumers. The reason is that the production level in a fishery is determined by the population characteristics of a naturally occurring stock as well as the number of productive units (fishing effort). Given these population characteristics, the maximum sustainable yield production level (and corresponding fishing effort level) are determined. The result in most fisheries would be that at a regulated price, market shortages (quantity demanded greater than quantity supplied) would require some form of non-price rationing.

Aside from the difficulties of passing the economic advantage of efficiency directly to consumers, there are other reasons to explain why limited entry has not been more widely received in marine fisheries. Perhaps it has something to do with the common property heritage of fisheries and the fact that overfishing is a relatively new phenomenon. I suspect the main reason is that limited entry is seldom contemplated until *after* overcapitalization occurs. Then both the efficiency and profitability criteria require a reduction in effort as compared to the orderly expansion of activities in an industry consistently under the tutelage of a limited entry program. The problems of having to exclude active participants as compared to not allowing them to enter in the first place is the central issue of this paper

concerning limiting entry into the already overcapitalized Florida spiny lobster fishery.

HISTORY OF THE FISHERY

The Florida spiny lobster fishery is a likely candidate for considering limited entry because the biology, economics, and historical regulations provide a satisfactory distinction between overcapitalization and overfishing. The reproductive potential of the stock is protected by a minimum size restriction (3.0-in carapace or 5.5-in tail) and closed season (April - July). Given long life, high fecundity, and questionable larval origins, it is expected that there is a weak stock-recruitment relationship. At 3.0- in carapace length approximately 14% of the females are expected to spawn (Gulf of Mexico Fishery Management Council, 1980). The fact that landings have remained relatively constant since the fishery has been fully exploited (1960-79) suggests no signs of recruitment overfishing.

The existing size restrictions permit some growth overfishing. The maximum yield-per-recruit occurs at approximately 3.5- in carapace length. While the 3.0- in carapace length reduces potential landings by weight by approximately 14% of the theoretical maximum, this is considered justifiable because of commercial market and recreational harvesting advantages associated with the 3.0- in carapace size (Gulf of Mexico Fishery Management Council, 1980).

Given that the resource is protected from recruitment overfishing and a small amount of growth overfishing is allowed as being justifiable, the commercial fishery is considerably overcapitalized.

Florida commercial landings and fishing effort (traps fished) are recorded by west coast (primarily Florida Keys, Monroe County, Florida); east coast (primarily Miami area, Dade County, Florida); and international (composed primarily of lobsters originating from the Bahamas). Florida areas are shown in Davis and Dodrill (1980, 201). The most reliable production data in terms of landings and traps fished is the west coast data (Williams, 1976). Annual and seasonal data are available from the author.

Traps in the west coast fishery have increased from 54,640 in 1960 to 227,250 in 1974 while total landings (whole weight in pounds) has peaked at around 5 million pounds during the same period. A simple ordinary least squares regression of the average annual (season, August to March) catch per trap (C/T) on the number of traps fished (T) indicates that the fishery is overcapitalized. That is, annually, fewer traps could harvest the same catch. The subscript (y) refers to year.

$$C_y/T_y = 100.72\, e^{-.00001\, T_y} \qquad (1)$$

$$n = 14\ (1960\text{-}74);\ F = 190;\ R^2 = .94058;\ \text{and D.W.} = 1.57.$$

Best statistical fit in the mathematical form discussed by Fox (1970), where:

C_y = Annual (fishing season, August to March) west coast catch in pounds whole weight in year y. Minimum legal size whole weight is approximately one pound therefore pounds and number of lobsters landed are nearly the same.

T_y = Total west coast traps fished in year y.

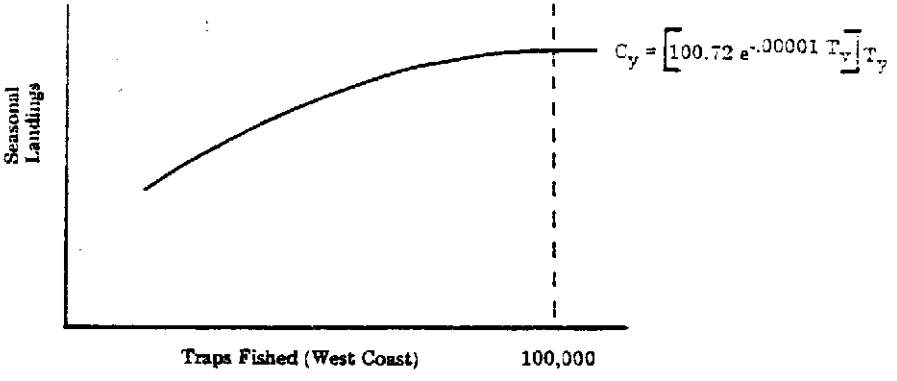

Figure 1. Annual production function for West Coast spiny lobster trap fishing.

Total annual catch is, by definition, the average annual catch per trap (C_y/T_y) times the number of traps fished (T_y) (Fig. 1).

$$C_y = [100.72\, e^{-.00001 T_y}]\, T_y \qquad (2)$$

Taking the first derivative of (2) with respect to the number of traps fished and setting that derivative equal to zero to solve for the number of traps where an increase in the number of traps no longer increases the annual landings yield.

$$\overline{T}_y = 100{,}000 \qquad (3)$$

where: $T_y \Rightarrow \frac{d\, C_y}{dT_y} = 0$ and $\frac{d^2 C_y}{dT^2_y} < 0$.

Based on 300,000 traps in the Florida Keys fishery in 1976 (Gulf of Mexico Fishery Management Council, 1980[1]), from equation (1), it can be calculated that a reduction to 100,000 traps would result in a 211% increase in catch per trap. Since the fishermen would not incur significantly higher costs from a higher catch rate per trap, the higher catch rate would translate into increased profits.

It should not be surprising that arguments for limited entry do not come from consumers or fishermen based on the rationale of national economic efficiency. The argument inevitably comes (when it does) from fishermen who argue that at some point continued common porperty (open access) fishing threatens their individual economic well being. From a theoretical point of view, this is arguing that economic rent (income above covering opportunity cost) is justifiable.

FISHERMEN'S OPINIONS ABOUT LIMITED ENTRY

In an overcapitalized fishery the goals of increased efficiency and/or profitability can only be achieved by *reducing* fishing effort. This creates a difficult situation

[1] 1974-75 was the last year the number of traps were recorded on state permits.

because fishermen (and the whole economy through increased national efficiency) can only benefit through the exclusion of some active fishermen. Most fishermen know their opportunity cost which means that their next best alternative (other fisheries or other occupations) is less attractive than what they are presently doing even in an overcapitalized fishery. Excluding active fishermen "boils down" to some people being economically damaged for the benefit of others.

Recognizing the resulting profitability from limited entry, it is likely that fishermen (as businessmen) would support limited entry, if they knew they would not be among the unfortunate ones excluded under the limited entry scheme. Spiny lobster permit holders completed questionnaires regarding limited entry into the Florida spiny lobster *(Panulirus argus)* fishery. The questionnaire was administered through the Florida Department of Natural Resources and was financially supported by the Ford Foundation as part of a larger study on the bio-economic and legal implications of limited entry into the Florida spiny lobster fishery.[2]

During the month of July (1979) questionnaires were mailed to a population of 2,048 persons holding 1978-79 spiny lobster permits. Ninety-one questionnaires were returned for incorrect or no forwarding addresses. Fifteen percent (294 questionnaires) were returned completed.

For the purposes of the questionnaire, "limited entry" was given a precise definition that excluded the possibility that economic rent would be purposely taxed away or in some way eliminated. However, the option of auctioning licenses which could theoretically capture economic rent was an alternative. (Smith, 1969; Willliams, 1976; Burke, 1977).

The questionnaire addressed the following points: (a) whether or not some form of limited entry was justifiable, (b) alternative exclusionary rules required to reduce fishing effort, (c) transferability of permits, (d) restricting the number of traps (fishing effort) of each permit holder, (e) alternatives to limited entry and (f) general economic information about the fishermen. Responses were analyzed in terms of frequency and joint frequency distributions. Frequency distributions are discussed with regards to opinions about limited entry and exclusionary rules, alternatives to limited entry, and reported economic characteristics of the permit holder. Joint frequency distribution are discussed with regards to opinions about various limited entry schemes, exclusionary rules, transfer of permits, and alternatives to limited entry according to the economic characteristics of the permit holder (gear, number of traps fished during the 1978/79 season, years held permit, percent of catch sold, and percent of income from lobsters).

The majority of respondents (57.8%) felt that the economic condition of spiny lobster fishermen, because of the growing number of fishermen, is sufficiently low to warrant the State and/or Federal government considering some form of limited entry. Of course, the fundamental issue is what "exclusionary rule" would be used to reduce the effort under limited entry.

Fishermen were asked to grade alternative exclusionary rules according to *fairness* (equity), *effectiveness in preserving the resource* and *enforceability*. The exclusionary rule deemed most fair (70.8%) was to stop issuing new permits; 66.2% felt it was effective and 79.4% felt it was enforceable. Reducing the number of

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[2]Ford Foundation Grant No. 785-0324

permits on the bases of last in first out was not as fair (32.5%), but 67.9% felt it was effective and 76.2% thought it was enforceable. Reducing the number of permits according to a permit holder's past landings of spiny lobster or how important past spiny lobster fishing has been for the permit holder's income were deemed less fair (21.7% and 32.2%, respectively), less effective (32.5% and 37.3%, respectively) and less enforceable (31.8% and 38.9%, respectively). Reducing the number of permits by auctioning to the highest bidders or by having a lottery for permits was considered to be not fair with 95.7% and 90.4%, respectively, of the respondents. These were graded by 30.6% and 40.7% as being effective and 43.7% and 50.0% as enforceable.

For a restricted number of permits to continuously result in higher landings (and revenue) per trap, it would be necessary to restrict the total number of traps fished. The majority (52.9%) of respondents felt it would not be possible to effectively enforce a restriction on the number of traps that could be fished by any one permit holder.

Since only a limited number of permits would be issued in a limited entry fishery some method must be devised to transfer permits when a permit holder leaves the fishery. The return of inactive permits to the government was considered most fair (73.2%) as compared to 39.8% who thought private re-sale was fair. Government control of permits was also chosen more effective and enforceable than private re-sale (74.5% and 94.5%, respectively versus 48.3% and 54.6%).

Information about the economic characteristics of permit holders was also obtained from the questionnaire. The majority (93.1%) of the respondents fished only one boat per permit, while 6.6% fished two boats and 0.3% fished three boats per permit. The most common boat sizes were 16-22 feet and 24-28 feet (36.9% each), while boats between 31-36 feet were used by 13.9% of the fishermen. Boats over 40 feet accounted for 12.2% and those under 16 only 3.1% of the vessels in the fleet.

Trap fishermen comprised a greater percentage of respondents than did divers (42.9% versus 29.1%). Persons that used both traps and diving (24.6%) were presumed to be recreational fishermen that used a few traps in addition to diving for lobsters. Approximately 19% of the respondents did not fish traps during the 1978-79 season. Approximately 66.9% of the spiny lobster permit holders are part-time fishermen.

The percentage distribution of spiny lobster permit holders (1978-79) by number of traps fished is: 75.6, 100 or less; 9.2, 101 to 200; 0.9, 201 to 300; 5.5, 301 to 500; 2.3, 501 to 700; 6.5, 701 or greater. Assuming this size composition of the traps per permit holds, the number of traps fished could theoretically be reduced by approximately 50% (without reducing landings) by reducing the number of permit holders by approximately 50% (from 1824 permits 1975-1976 to 912 permits). In a more extreme action, the industry could encourage what has been estimated to be the most profitable size operation (Williams, 1976), which would only require 200 permits in the Florida Keys. Table 1 indicates the number of permits that would be required to harvest the West Coast (Florida Keys) exploitable stock given different number of traps fished per permit.

In the majority of cases (96.2%) the permit holder was the owner of the vessel and traps and 96.9% of the time the permit holder actively conducted the fishing. Only

Table 1. Number of permits required to harvest existing landings with different size operations (traps fished per permit).

Required Number Permits to Harvest 5 million lb	Traps Per Permit	Total Traps Fished
1,000	100	100,000
500	200	"
333	300	"
250	400	"
200	500*	"
167	600	"
143	700	"
125	800	"
111	900	"
100	1,000	"

15.2% of the respondents were less than 31 years old, while 29.1% were 31-40 years old and 29.8% were 41-50 years old. A large portion of respondents (25.9%) were 51 years and older.

Length of time resident in Florida ranged from 1-5 (8.3%) years up to 71-75 (0.3%) years; 22.8% were Florida residents for 10 years or less years while 48.1% were Florida residents for 20 or less years. In contrast, the number of years a permit holder has continuously held a permit ranged from 1-5 years (61.9%) up to 26-30 years (1.0%); 88.5% held permits for 10 or less years while 97.2% held permits for 20 or less years.

The percentage of catch sold ranged from zero (26.4%) to between 91-100% (46.1%); 38.2% sold 50% or less of their catch while 61.1% sold more than 70% of their catch. The percentage of income derived from lobster fishing ranged from zero (33.5%) up to 91-100% (14.4%); 69.6% derived less than 50% of their income from lobster fishing and only 27.3% received 70% or more of their income from lobster fishing. The most popular fishing done in conjunction with lobster fishing was snapper/grouper fishing (22.7%). A combination of yellowtail, stone crab and snapper/grouper fishing accounted for an additional 18.3%.

Jobs outside commercial fishing were held by 66.9% of the respondents; only 33.1% relied on commercial fishing alone for their annual income. Fishermen with a high school or below education accounted for 21.3% of the responses, whereas 62.4% had more than a high school education.

Five economic characteristics relate most closely to the expected self interest that would be reflected in opinions about alternative policies: (1) fishing gear, (2) number of traps fished, (3) number of years the permit holder has continuously held a spiny lobster permit, (4) percent of catch sold and (5) percent of income derived from spiny lobster fishing. These characteristics are correlated with one another (Table 2).

Table 2. Probability (Chi-square test) that the economic characteristics are not related

	Method	Number Traps Fished Last Season	Years Held Permit	Percent Catch Sold	Percent Lobster Income
Method	—	0.0000	0.0108	0.1554	0.0000
Number traps fished last season		—	0.0032	0.0001	0.0000
Years held permit			—	0.4486	0.0000
Percent catch sold				—	0.0000
Percent lobster income					—

Percent of income derived from spiny lobster fishing was significantly correlated with each of the remaining four characteristics (Table 2). Method fished by percent income showed that as the percent income increased the majority of respondents were trap fishermen. An increase in the percent income from lobster fishing also implied an increase in the number of traps fished last season. The longer a respondent held a permit the greater was his dependence on spiny lobster for his income. As would be expected, as the percent of catch sold increased so did the percent income from spiny lobster fishing.

The *percent of catch sold* was significant with respect to percent income from spiny lobster fishing and number of traps fished last season, but was not significantly related to method (gear) or the number of years a permit was held. Method (gear) was not significant because such a uniformly large percent of divers (that have permits) as well as trap fishermen sell their catch. Percent of catch sold with respect to number years a permit was held was the least significant of the five characteristics (0.4486). This simply implies that people enter the fishery to sell their catch and continue doing so as long as they hold permits.

The *number of years a permit holder has continuously held a spiny lobster permit* was significantly related to method, number traps fished last season and percent income from spiny lobster fishing (previously discussed). The longer a permit was held was related to number of traps fished because this represented the veteran commercial trap fishermen.

The *number of traps fished in the previous season* was expected to have a strong relationship with longevity in the fishery. This was the case as indicated by significant relationships with method (gear), years held permit, percent catch sold and percent income from spiny lobster fishing.

Method (gear) was significantly related to number of traps fished last season, number years held permit and percent income from spiny lobster fishing.

Our attempt to find relationships between opinions and economic characteristics (joint frequency distributions, Chi-square tests) was to determine if the prevailing economic characteristics actually defined the potential political constituency for any policy.

Table 3. Expected direct (D) and indirect (I) support for a policy (columns) according to economic characteristics of the permit holders (rows). See Table 2

Economic Characteristics	Limited Entry Exclusionary Rules				
	Last In Then First First Out	Percent Income From Lobster	Past Landings	Limit Number Traps Per Permit	Limit Catch Per Permit
Method (gear)		I	I	I	I
Number traps fish last season	I	I	D	D	D
Years held permit	D	I		I	I
Percent catch sold		I	I	I	I
Percent income from lobsters	I	D	I	I	I

No relationships existed for the following optional exclusionary rules and thus they have not been included in the above table: Is limited entry necessary, stop issuing new permits, Lottery permits, Auction permits, Transferability of permit.

If the economic characteristics of the permit holders do condition their opinions about alternative policies, then the fact that the economic characteristics are related to each other as just described (Table 2) allows us to predict the composite political constituencies for the alternative policies.

Table 3 is a matrix of the economic characteristics and the alternative policies. A direct self interest relationship between a policy and an economic characteristic is specified with a (D). Where there is an indirect relationship between an economic characteristic and the policy because that economic characteristic is related to the direct characteristic is specified with an (I). Blank cells imply that there is no direct relationship between a policy and an economic characteristic. Without relationship to an economic characteristic, a policy could have broad support by all economic characteristics or no support by any characteristic.

Opinions about alternative management policies were asked with respect to (1) fairness (equity), (2) effectiveness in preserving the resource, and (3) enforceability. The responses are summarized in Table 4. The ability of permit holders to discriminate between these three separate issues is apparent in the results.

In Table 4, the three numbers in each cell are the probabilities that fairness (first number), effectiveness (second number), and enforceability (third number) are *not* related to the economic characteristic (Chi-square test). Significance is defined at the 0.10 level (or lower). The plus or minus sign after each probability simply indicates whether more than 50% of the respondents agree (+) or disagree (-) with the fairness, effectiveness, or enforceability of the policy.[3]

The majority of permit holders believe that the economic status of fishermen is such to warrant State and/or Federal limited entry. Approval by three characteristics were significant. They were number of traps fished last season (0.0779), years held permit (0.0819) and percent of catch sold (0.0339). Method was

[3]Signs (+, —) in every cell in each column are always the same because each economic characteristic includes the whole sample.

Table 4. Opinions on fairness, effectiveness & enforceability of alternative limited entry policies (columns) according to economic characteristics of the permit holders (rows). Probability (Chi-square test) that opinions & economic characteristics are not related.

	Do economic conditions warrant limited entry	Stop issuing new permits	Exclude based on last in, first out	Exclude based on importance for income	Exclude based on past landings	Exclude by lottery	Exclude by auction
Diving		.8427+	.5158-0-	.1154-	.3751-	.8649-	
traps	.8821+	.4051+	.9036+	.7346-	.8108-	.4573-	.5613-
both		.7605+	.8089+	.9759-	.7007-	.4472+	.4280-
Number		.0387+	.1713-	.0001-	.0631-	.5983-	.1201-
of traps	.0779+	.5845+	.3668+	.0157-	.7219-	.9575-	.4079-
fished		.3213+	.1044+	.1137-	.8185-	.4827-	.4487-
Years		.1839+	.0044-	.2030-	.1342-	.9627-	.9596-
Held	.0819+	.2831+	.0221+	.2410-	.3402-	.6096-	.6667-
Permit		.1548+	.0224+	.0874-	.1222-	.0980-	.7805-
%		.6673+	.5967-	.7073-	.1432-	.6861-	.1112-
Catch	.0339+	.8435+	.7231+	.7896-	.8597-	.5841-	.1144-
Sold		.8066+	.4093+	.9462-	.7608-	.1359-	.2276-
% Income		.1137+	.3007-	.0311-	.0079-	.3143-	.4652-
from lobster	.6153+	.6204+	.4399+	.6293-	.2678-	.3467-	.1132-
fishing		.4017+	.6875+	.3522-	.1536-	.0701+	.0792-

Table 4 — Continued

	Are trap restrictions enforceable?	Inactive permits should be returned to the Government	Permits should be marketable	Limit number of traps per boat
Diving		.9502+	.7748-	.1613+
traps	.1351-	.9749+	.8972+	.7959+
both		.8025+	.7083+	.4460-
Number		.9070+	.0126-	.4075+
of traps	.1118-	.5857+	.0588+	.4213+
fished		.2775+	.0401+	.0894-
Years		.2348+	.0518-	.0077+
Held	.2507-	.1112+	.1094+	.0523+
Permit		.0673+	.1454+	.2338+
%		.6840+	.5561-	.1627+
Catch	.2822-	.6443+	.4202+	.1658+
Sold		.5075+	.7986+	.4055-
% Income		.7480+	.4829-	.0598+
from lobster	.1879-	.8325+	.2848+	.2095+
fishing		.9015+	.4035+	.5460-

not significant (0.8821). Persons fishing by traps, traps and diving, or diving were equally divided in their response either in support of or disapproval of limited entry. Percent income from spiny lobster fishing was not significant because a sufficient number of respondents were equally divided in their response and these responses were composed of persons selling varying percentages of their catch.

Limited entry necessitates the exclusion of some fishermen according to some exclusionary rules. Stop issuing new permits is, as might be expected, acceptable to the majority. Only one, number of traps fished in the previous season, was significant at the 0.10 level (fairness = 0.0387). The greater the number of traps fished implies larger and more established operations are more willing to exclude new fishermen. The relationship was also near significance for percent of income from spiny lobster fishing (fairness = 0.1137). There was also a relationship between the length of time the permit holder has continuously held a spiny lobster permit (fairness = 0.1839, effectiveness = 0.2831 and enforceability = 0.1548).

Decreasing the number of permits based on the importance past spiny lobster fishing had for the permit holder's income was disapproved by a majority on the basis of fairness, effectiveness and enforceability. The relationship was significant for number of traps fished last season (fairness = 0.0001, effectiveness = 0.0157), and percent income from spiny lobster fishing (fairness = 0.0311). The only significant relationship for enforceability is with longevity (0.0874) which suggests the older more established fishermen are of the opinion that this would be enforceable by requiring proof of income importance by examining fish sales tickets or income tax returns.

Reducing the number of permits according to a permit holder's past landings of spiny lobster was also rejected by a majority. Opinions closely follow those for reduction according to importance of spiny lobster fishing to income. Number of traps fished last season and percent income from spiny lobster fishing were both significant for fairness (0.0631 and 0.0079, respectively). Longevity was very close to being significant (0.1222). Reducing the number of permits according to past landings was also almost significant in terms of fairness for gear (0.1154). longevity (0.1342) and percent of catch sold (0.1432).

Reducing the number of permits by lottery or auction were the most rejected alternatives. The only exceptions were in enforceability where approximately 50% approved and disapproved about its enforceability. The only significant relationships for a lottery were years held permit (enforceability = 0.0980) and percent income from spiny lobster fishing (enforceability = 0.0701). The only other strong relationship was percent of catch sold (enforceability = 0.1359). Auctioning to the highest bidder was only significantly related to percent income from lobster fishing (enforceability = 0.0792). However, the relationship was strong for number traps fished last season (fairness = 0.1201), percent catch sold (fairness = 0.1112, effectiveness = 0.1144) and percent income from spiny lobster fishing (effectiveness = 0.1132).

Limited entry would only reduce effort if the number of traps fished per permit holder could also be limited. This was disapproved by the majority. The relationship was not significant for any characteristics; however, there was a relationship for gear (0.1351), number of traps fished last season (0.1118) and percent income from spiny lobster fishing (0.1879). This was expected because a trap fishermen (gear) that

fished many traps and derived a large percentage of income from spiny lobster fishing would not want to limit the number of traps fished per permit holder.

Finally, in a limited entry fishery some mechanism of permit transfer must be established. Government transfer of permits was approved by the majority on the bases of fairness, effectiveness and enforceability. The only significant relationship was with number of years held permit (enforceability = 0.0673). The relationship was also strong for fairness (0.2348) and effectiveness (0.1112). The more established fishermen felt the government would provide a better mechanism for an equitable permit transfer. Private sale of permits was disapproved by the majority on the basis of fairness but appproved on the basis of effectiveness and enforceability. The relationship was significant with the number of traps fished last season (fairness = 0.0126, effectiveness = 0.0588 and enforceability = 0.0401) and years held permit (fairness = 0.0518). The relationship was also strong for effectiveness (0.1094) and enforceability (0.1454) of years held permit. The larger operation (more traps) was expected to prefer private sale. The longer a permit holder has held a permit, the stronger the relationship for private sale. The two characteristics (number of traps fished last season and longevity) are related, which explains their similar responses.

OPINIONS ABOUT ALTERNATIVES TO LIMITED ENTRY

A number of alternatives to limited entry were listed and respondents were asked to grade each according to fairness, effectiveness, and enforceability (Table 5). A majority approved limiting the number of traps per boat as being fair and effective; however, it was deemed unenforceable. The relationship was significant for number of traps fished last season (enforceability = 0.0894), years held permit (fairness = 0.0077; effectiveness = 0.0523) and percent income from spiny lobster fishing (fairness = 0.0598). For the characteristic of number of traps fished last season, responses by those fishing zero traps (diving) was sufficient to weaken the relationship (0.4075).

A closed season received a majority approval for fairness, effectiveness, and enforceability. The relationship was significant for method used (fairness = 0.0002, effectiveness = 0.0793), number of traps fished last season (fairness = 0.0209), percent catch sold (fairness = 0.0166) and percent income from spiny lobster fishing (fairness = 0.0000). This is a traditional method and was expected to have wide acceptance.

Limiting trap size is another possible management practise and its widespread acceptance was indicated by the large number of significant relationships and approval on the basis of fairness and enforceability. However, it is important to note that all characteristics indicated that was not effective.

Closed areas are beginning to be used in managing the spiny lobster fishery. It was approved across all characteristics for fairness, effectiveness and enforceability. The relationships were either significant or very strong for all characteristics indicating a correlation between support for this policy and economic characteristics.

Limiting the catch per boat was disapproved by the majority on the basis on fairness, effectiveness, and enforceability. The relationships were all significant or strong as predicted by Table 3.

Limiting the commercial or recreational fishery were both disapproved by the majority. However, the fact that there are correlations between approval of limiting commerial fishing and the economic characteristics of the commercial fishermen,

Table 5. Opinions on fairness, effectiveness and enforceability of policies other than limited entry (columns) according to economic characteristics of permit holders (rows). Probability (Chi-square test) that opinions and economic characteristics are not related.

	Do economic conditions warrant other regulations	Limit number of traps per boat	Close season	Regulate trap size	Designate closed areas	Limit catch per boat	Limit commercial fishing	Limit recreational fishing
Diving		.1613+	.0002+	.0012+	.0372+	.0034-	.0005-	.1964-
traps	.9944+	.7959+	.0793+	.0099+	.0195+	.0070-	.0001-	.6028-
both		.4460-	.1089+	.0142+	.1876+	.0056-	.0030-	.7514-
Number		.4075+	.0209+	.0161+	.0002+	.0247-	.0174-	.2603-
of traps	.2525+	.4213+	.7031+	.5023-	.0041+	.4888-	.0565-	.6716-
fished		.0894-	.7734+	.2862+	.0298+	.0917-	.4788-	.8911-
Years		.0077+	.4570+	.0000+	.2256+	.1799-	.0599-	.6206-
Held	.1167+	.0523+	.1618+	.0000+	.0688+	.3013-	.0899-	.9558-
Permit		.2338+	.5056+	.0001+	.3341+	.1397-	.2488-	.7218-
%		.1627+	.0166+	.1252+	.0120+	.0016-	.0008-	.6870-
Catch	.9934+	.1658+	.2189+	.0476-	.0075+	.0091-	.0351+	.3780-
Sold		.4055-	.9479+	.5816+	.0865+	.0730-	.3750-	.5574-
% Income		.0598+	.0000+	.0191+	.0064+	.0003-	.0388-	.9708-
from Lobster	.7368+	.2095+	.2503+	.0756-	.0037+	.0869-	.2012-	.9673-
Fishing		.5460-	.4335+	.0648+	.1608+	.2536-	.9165-	.9998-

but no correlation for limiting recreational fishing, supports the hypothesis of this paper. Similar to the exclusionary rules of a lottery or auctioning permits, there are no correlations when there are no economic advantages of a policy by economic characteristics. Limiting recreational fishing would have the same impact across all economic characteristics of commercial fishermen. The correlation between economic characteristics and approval of limiting commercial fishing occurs because there are economic advantages by economic characteristics for limiting commercial fishing.

SUMMARY AND CONCLUSIONS

The first step in limited entry is recognizing that limited entry is a form of economic regulation that is justified (when it is) by the objectives of economic efficiency or profitability. In this regard it is nothing new and has wide precedent in numerous sectors of most economies. The main distinction is that it can be difficult (sometimes impossible) to prevent economic rent from accruing or directly passing on the advantages of economic efficiency to consumers.

The most difficult aspect of limited entry relates to the fact that it is not normally considered until after a fishery is overcapitalized. Then the economic objectives can only be achieved by excluding active participants in the fishery. This means there will be dissension within the fishery over whatever exclusionary rules are employed to reduce fishing effort. Furthermore, whichever limited entry exclusionary rule is

selected, it will have varying impacts on different identifiable groups (e.g. longevity, size and type operation, economic dependence on the fishery) which can support arguments that limited entry is discriminatory in result even though it may not be discriminatory in purpose.

In the case of Florida spiny lobster, a majority of permit holders believe that the economic conditions of the fishermen are such to warrant State or Federal limited entry considerations, but there is no majority agreement on any specific policy except that no new permits should be issued. Obviously, any ongoing enterprise in an industry would welcome the opportunity to prohibit further competition.

A majority were opposed (fairness) to all five limited entry exclusionary rules to reduce fishing effort. The lottery and auction alternatives were the most rejected policies because they have no political constituency (offer no assured advantage to any economic group). In a lottery the economic condition of the winners would be improved because economic rent would accrue to the smaller number of fishermen. Of course there is no political constituency because there is no way of anyone knowing in advance if they would be chosen in the lottery.

The auction alternative is the least popular because it does not have support by those that would be excluded *or those that would be permitted to fish.* The reason is that it can be anticipated that the auctioning process will lead to bids for permits that equal or nearly equal the economic rent that would accrue because of the fewer number of fishermen. The result is that, after purchasing the permit, fishermen would not be any better off economically under limited entry than they are with the present arrangement.

The exclusionary rules of last in first out, importance to income, and past landings, all have political constituencies in the economic characteristics of longevity (years held permit), percent of income from fishing and catch sold, and number of traps fished. All these characteristics are related such that *if any one of these exclusionary rules is chosen, the result would be the same as if any of the other exclusionary rules were chosen.* That is, if existing permit holders are excluded on the basis of last in then first out (years held permit), the result will be exclusion by number of traps fished (reflecting landings), and percent income from lobster fishing.

If the exclusionary rule of past landings was chosen (eliminate small part time operator) then the results will still be exclusion by longevity, traps fished, and percent income from lobster fishing. Exclusion by past landings or percent of income from lobster fishing has the same results.

The exclusionary rules that all have the same results (when measured by their impact on different economic groups) do have a common political interest group. While the majority of permit holders disapprove of the exclusionary rules, should any one of them be proposed the opinions will be identifiable along a continuum of longevity in the fishery. The longer a permit holder has held a permit, the more likely he will be supportive of the exclusionary rules. Longevity is also an important characteristic politically because in the traditional setting of fisheries, seniority is a known and respected attribute. The result is that while the majority of permit holders disapprove of the exclusionary rules, support for these rules will be identifiable by seniority.

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